College of Arts, Technology and Environment
School of Engineering
ACADEMIC YEAR 2024/25

Assessment Brief

Submission details

Module title: Robot learning and teleoperation

Module code: UFME7R-15-M

Assessment title: Report of robot learning and teleoperation

Assessment type: Written report

Assessment weighting: 50% of total module mark

Size or length of assessment: maximum 1500 words

New Assessment Content Limit Policy for the University (sharepoint.com)

Module learning outcomes assessed by this task:

1. Apply robot learning algorithms to teach robots new skills and behaviours, enabling them to adapt and generalize from training data.

2. Design and implement teleoperation systems for safe and efficient human-robot interaction, with considerations of control architectures, communication protocols, and user interfaces.

Use of Generative AI (GenAI) in assessment:

	You can use Generative AI in this assignment for checking spelling, grammar etc.

Guidance on Referencing (inc AI):
Please note that the aim of referencing is to demonstrate you have read and understood a range of sources to evidence your key points. You need to list the references consistently and in such a way as to ensure the reader can follow up on the sources for themselves.
You must use the UWE Bristol Harvard referencing style.
Referencing - Study skills | UWE Bristol
Using generative AI at UWE Bristol - Study skills | UWE Bristol

艺术、技术与环境学院

工程学院

2024/25 学年

评估简报

提交详情

模块标题：机器人学习和遥操作

模块代码：UFME7R-15-M

评估标题：机器人学习与遥操作报告

评估类型：书面报告

评估权重：占模块总分的 50%

评估的大小或长度：最多 1500 个字

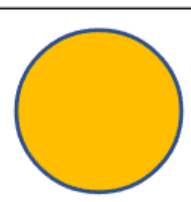
大学新的评估内容限制政策（sharepoint.com）

通过此任务评估的模块学习成果：

1. 应用机器人学习算法来教机器人新的技能和行为，使它们能够从训练数据中进行调整和概括。

2. 设计和实现远程操作系统，实现安全高效的人机交互，同时考虑控制架构、通信协议和用户界面。

生成式人工智能（GenAI）在评估中的应用：

	您可以在本次作业中使用生成式人工智能来检查拼写、语法等。

参考指南（包括人工智能）：
请注意，引用的目的是为了证明你已阅读并理解了一系列资料，从而佐证你的核心观点。你需要以一致的方式列出参考文献，并确保读者能够自行查找资料。

你必须使用西英格兰布里斯托尔哈佛大学的参考文献格式。参考文献 - 学习技巧 | 西英格兰布里斯托尔大学 在西英格兰布里斯托尔大学使用生成式人工智能 - 学习技巧 | 西英格兰布里斯

Submission and feedback dates

Submission deadline: Before 14:00 on 1st May 2025

This assessment is eligible for 48 hour late submission window

Submission format:

Submit your MLX file and a PDF render of it. This should be done with outputs, so you must Run the whole file successfully to display your results and graphs

Marks and Feedback due on: 30th May

N.B. all times are 24-hour clock, current local time (at time of submission) in the UK

Marks and Feedback will be provided via:
Blackboard

Completing your assessment

What am I required to do on this assessment?

The assessment task entails producing a technical report that details the integration of the acquired robot learning methodology and teleoperation. The report must be submitted prior to the deadline, following the instruction provided by the module leader. Please complete the report under the guidance with the following tasks and steps:

Task 1: Utilize Dynamic Movement Primitives (DMPs) discussed in the Robot Skill Generalisation, Gaussian Mixture Models (GMM) in Humane Skill Encoding, and Gaussian Mixture Regression (GMR) in Robot Skill Regression, to devise an enhanced Dynamic Movement Primitives for single-arm robot manipulation. During the development of the new algorithm, you can refer to the paper "DMP and GMR based Teaching by Demonstration for a KUKA LBR Robot" introduced in the reading week lecture. Write an introduction about the calculation steps based on your understanding of this paper into your own report. The relevant code is provided on the Blackboard. **(500 words, 10 Marks)**

Task 2: Implement your improved DMP method using the following steps **(50 marks)**

1) Employ DMPs to compute the values of nonlinear term (the forcing term) of the inputs. This step can be realized by using the code from original Dynamic Movement Primitives. **(10 Marks)**

2) Utilize Gaussian Mixture Models (GMM) and Gaussian Mixture Regression (GMR) instead of conventional nonlinear terms in DMP to carry out a nonlinear regression for the calculation results in step 1. **(15 Marks)**

3) Once the new trajectory has been learned and generalized, save the data in a .mat format to the workspace. **(5 Marks)**

提交和反馈日期

投稿截止日期：2025 年 5 月 1 日 14:00 前

此评估可享受 48 小时延迟提交窗口

投稿格式：

提交你的 MLX 文件及其 PDF 渲染图。这需要包含输出，因此你必须成功运行整个文件才能显示结果和图表。

评分和反馈截止日期：5 月 30 日

注意：所有时间均为 24 小时制，即英国当前当地时间（提交时）

分数和反馈将通过以下方式提供：
黑板

完成评估

我需要针对这次评估做什么？

评估任务需要撰写一份技术报告，详细说明所学机器人学习方法与远程操作的整合情况。报告必须在截止日期前提交，并遵循模块负责人的指示。请按照以下任务和步骤指导完成报告：

任务 1：利用机器人技能泛化中讨论的动态运动基元 (DMP)、人性化技能编码中的高斯混合模型 (GMM) 以及机器人技能回归中的高斯混合回归 (GMR)，设计一种用于单臂机器人操作的增强型动态运动基元。在新算法的开发过程中，你可以参考阅读周讲座中介绍的论文“基于 DMP 和 GMR 的 KUKA LBR 机器人演示教学”。请根据你对本文的理解，在你的报告中撰写一篇关于计算步骤的介绍。相关代码在黑板上提供。（500 字，10 分）

任务 2：使用以下步骤实施改进的 DMP 方法（50 分）

1) 使用动态运动模型 (DMP) 计算输入的非线性项（强制项）的值。此步骤可以使用原动态运动原语 (Dynamic Movement Primitives) 中的代码实现。（10 分）

2) 利用高斯混合模型（GMM）和高斯混合回归（GMR）代替 DMP 中的常规非线性项，对步骤 1 的计算结果进行非线性回归。（15 分）

3）一旦学习并推广了新的轨迹，请将数据以.mat 格式保存到工作区。（5 分）

4) During teleoperation simulation, load the saved data as inputs for the teleoperation system to facilitate further simulation. Please complete simulations and make a screenshot of the simulation results with the scopes to illustrate the simulation results. **(15 Marks)**

Task 3: Evaluate the proposed enhanced Dynamic Movement Primitives method by comparing the differences between the original Dynamic Movement Primitives and the enhanced method in Cartesian space coordinates. The successful results should demonstrate comparative fitting errors. Complete the comparison and analysis for the results and write them in the report. **(500 words, 15 Marks)**

Task 4: Save the outputs of robot learning and load them into the teleoperation model in Simulink as inputs on the leader controller side to guide the movement of the follower. By designing PD or other controllers on both the leader and follower, the expected outcome is for the follower's desired motions to mirror those on the leader side. Consequently, save and plot the positions on both the leader and follower sides, and compare the disparities between them. The comparison and the control diagram built in Simulink should also be included in the report. **(500 words, 15 Marks)**

Complete the aforementioned tasks and document them in your report. In the report, you should describe the complete process adopted in each task and make a comparison of the improved method against the general DMPs. You should also illustrate how the improved method can deal with the cooperative robot manipulation. The introduction of DMPs, the methodology, analysis and conclusions must be clearly and logically presented in the report. **(10 Marks)**

Where should I start?

The coursework will commence with a reading lecture introducing the paper 'Dynamic Movement Primitives for Cooperative Manipulation and Synchronized Motions,' wherein participants will learn how to apply the acquired method in actual research. Subsequently, please consult the codes provided by the module leader, located in the Blackboard folder, to gain a comprehensive understanding. Following this, proceed to enhance the algorithm introduced in the assessment section to meet the aforementioned tasks. Robot learning is employed to generate robot movement, and these motions are subsequently used as inputs for teleoperation. Please refer to the detailed tasks and complete this report containing the essential components presented in the Criteria.

What do I need to do to pass?

Pass(2:2) >50%: Load the data to realize motion planning using general dynamic movement primitives without improvement. Use the obtained data as inputs for teleoperation and implement PD control to achieve motion synchronization between the leader and followers.

Pass(2:1) >60%: Load the data to achieve motion planning employing improved dynamic movement primitives as per the provided reference. Utilize the acquired data for

4) 在遥操作仿真过程中，将保存的数据加载到遥操作系统中，以便进一步进行仿真。请完成仿真，并使用示波器截取仿真结果截图，以直观地展示仿真结果。（15 分）

任务 3：通过比较原始动态运动基元与增强方法在笛卡尔空间坐标系下的差异，评估所提出的增强动态运动基元方法。成功的结果应展示出可比的拟合误差。完成结果的比较和分析，并撰写报告。（500 字，15 分）

任务 4：保存机器人学习的输出，并将其加载到 Simulink 中的遥操作模型中，作为主控制器端的输入，以引导跟随器的运动。通过在主控制器和跟随器上设计 PD 或其他控制器，预期结果是跟随器的期望运动与主控制器端的运动一致。因此，请保存并绘制主控制器和跟随器端的位置图，并比较它们之间的差异。比较结果和 Simulink 中构建的控制图也应包含在报告中。（500 字，15 分）

完成上述任务并将其记录在报告中。报告中，你需要描述每个任务采用的完整流程，并将改进的方法与通用的决策管理方案 (DMP) 进行比较。你还需要说明改进的方法如何应用于协作机器人操作。报告中必须清晰、逻辑地呈现 DMP 的介绍、方法论、分析和结论。（10 分）

我应该从哪里开始?

课程将以阅读讲座开始，介绍论文“协作操作和同步运动的动态运动原语”，学员将学习如何将所学方法应用于实际研究。随后，请查阅模块负责人提供的位于 Blackboard 文件夹中的代码，以全面理解。之后，继续增强评估部分介绍的算法，以满足上述任务。机器人学习用于生成机器人运动，随后将这些运动作为远程操作的输入。请参考详细任务并完成此报告，其中包含标准中提出的基本要素。

我需要做什么才能通过?

Pass(2:2) >50%：加载数据，使用无需改进的通用动态运动原语实现运动规划。将获取的数据作为遥操作的输入，并实施 PD 控制，实现主机器人与从机器人之间的运动同步。

通过率(2:1) >60%：根据提供的参考，加载数据，采用改进的动态运动原语实现运动规划。利用获取的数据进行

teleoperation inputs and employ PD control to ensure motion synchronization among the leader and followers. The report contains essential sections and provides sufficient evidence.

Distinct >70%: Load the data and employ improved dynamic movement primitives based on the provided reference for motion planning. Utilize basic control methods except for the PD control to achieve motion synchronization among the leader and followers during teleoperation. Conduct a detailed analysis of robot execution. The report's essential sections are clearly presented.

How do I achieve high marks in this assessment?

Please refer to the above criteria to achieve high marks.

How does the learning and teaching relate to the assessment?

All the lectures and tutorials covered all the sections relating to this coursework e.g., Linear regression, Human skill encoding, Robot skill regression and Skill generalisation with Dynamics to teach robots new skills and behaviours. The generalized trajectories are utilized for robot teleoperation. Hence, students are required to integrate robot learning and teleoperation to fulfil the assessment.

What additional resources may help me complete this assessment?

The uploaded code and slides provide in the Blackboard Folder.

What do I do if I am concerned about completing this assessment?

It is recommended that you review all of the relevant materials on Blackboard. You can also speak to your module leader for advice and guidance.

UWE Bristol offer a range of Assessment Support Options that you can explore through this link, and both Academic Support and Wellbeing Support are available.

For further information, please see the Student study essentials.

How do I avoid an Assessment Offence on this module?

Use the support above if you feel unable to submit your own work for this module.

1. Complete the assessment following the guidance of this module
2. Writing in the correct form following the guidance of this template
3. Avoid copying code and context from the internet or using AI Tools.

遥操作输入采用 PD 控制，确保主机器人和从机器人的运动同步。报告包含必要的章节，并提供了充分的证据。

差异 >70%：加载数据并根据提供的参考文献采用改进的动态运动原语进行运动规划。利用除 PD 控制之外的基本控制方法，实现远程操作过程中主机器人和从机器人之间的运动同步。对机器人的执行情况进行详细分析。报告的主要章节清晰呈现。

我怎样才能在这次评估中取得高分？

请参考上述标准以获得高分。

学习和教学与评估有何关系？

所有讲座和辅导课涵盖了与本课程相关的所有部分，例如线性回归、人类技能编码、机器人技能回归以及基于动力学的技能泛化，旨在教授机器人新的技能和行为。泛化轨迹用于机器人的远程操作。因此，学生需要将机器人学习与远程操作相结合才能完成评估。

哪些额外的资源可以帮助我完成此评估？

上传的代码和幻灯片在 Blackboard 文件夹中提供。

如果我担心无法完成此评估，该怎么办？

建议您复习 Blackboard 上的所有相关资料。您也可以联系您的模块负责人，寻求建议和指导。

西英格兰大学布里斯托尔分校提供一系列评估支持选项，您可以通过此链接进行探索，并且提供学术支持和健康支持。

欲了解更多信息，请参阅学生学习要点。

我该如何避免此模块的评估违规？

如果您觉得无法为该模块提交自己的作品，请使用上面的支持。

1. 按照本模块的指导完成评估 2. 按照本模板的指导以正确的形式书写
3. 避免从互联网复制代码和上下文或使用 AI 工具。

4. Ensure the complement of all the task work and present the improvement to the original algorithm
5. Complete the report.

Marks and Feedback

Your assessment will be evaluated according to the mark allocations described in the tasks .

1. In line with UWE Bristol's Assessment Content Limit Policy (formerly the Word Count Policy), word count includes all text, including (but not limited to): the main body of text (including headings), all citations (both in and out of brackets), text boxes, tables and graphs, figures and diagrams, quotes, lists.
2. UWE Bristol's UWE's Assessment Offences Policy requires that you submit work that is entirely your own and reflects your own learning, so it is important to:
    - Ensure you reference all sources used, using the UWE Harvard and the guidance available on UWE's Study Skills referencing pages.
    - Refer to peer reviewed primary sources, rather than using AI or secondary sources
    - Avoid copying and pasting any work into this assessment, including your own previous assessments, work from other students or internet sources
    - Develop your own style, arguments and wording, so avoid copying sources and changing individual words but keeping, essentially, the same sentences and/or structures from other sources
    - Never give your work to others who may copy it
    - If an individual assessment, develop your own work and preparation, and do not allow anyone to make amends on your work (including proof-readers, who may highlight issues but not edit the work) and

When submitting your work, you will be required to confirm that the work is your own, and text-matching software and other methods are routinely used to check submissions against other submissions to the university and internet sources. Details of what constitutes plagiarism and how to avoid it can be found on UWE's Study Skills pages about avoiding plagiarism.

4. 确保所有任务工作的完成，并对原有算法提出改进。5. 完成报告。

评分和反馈

您的评估将根据任务中描述的分数分配进行评估。

1. 根据西英格兰大学布里斯托尔分校的评估内容限制政策（以前称为字数统计政策），字数统计包括所有文本，包括（但不限于）：正文（包括标题）、所有引用（括号内和括号外）、文本框、表格和图表、图表、引文、列表。
2. 西英格兰大学布里斯托尔分校的《评估违规政策》要求您提交完全属于您自己的、能够反映您自身学习成果的作业，因此，以下几点非常重要：
    - 确保引用所有使用的来源，使用 UWE Harvard 和 UWE 学习技巧参考页面上提供的指导。
    - 参考同行评审的主要来源，而不是使用人工智能或二手资料
    - 避免将任何作业复制粘贴到此评估中，包括您自己以前的评估、其他学生的作业或互联网来源的作业
    - 形成自己的风格、论点和措辞，避免抄袭来源和更改个别单词，但本质上要保留其他来源的相同句子和/或结构
    - 切勿将您的作品提供给可能抄袭的其他人
    - 如果是个人评估，请自行开展工作和准备工作，并且不允许任何人修改您的工作（包括校对员，他们可能会指出问题，但不会编辑工作），并且

    提交作品时，您需要确认该作品是您的
    论文通常会使用自己的文本匹配软件和其他方法，将提交的论文与大学提交的其他论文和网络资源进行核对。关于抄袭的构成以及如何避免抄袭的详细信息，请参阅西英格兰大学关于如何避免抄袭的学习技巧页面。